Compartment Syndrome

The Sneaky Emergency

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## Case Study

- 36 yr old male
- Obese
- POD 1 s/p L mandibulectomy, L neck dissection with R fibula reconstruction
- 10 hour long supine position
- Intubated in PACU overnight (12 hours)
- PCA for pain

### Complaints
- Extreme R buttock pain – exquisitely tender to touch
- Erythema localized to right buttock
- Swollen R buttock
What is compartment syndrome?

A condition in which increased compartment pressure within a confined space, compromises the circulation and viability of the tissues within that space.
The first medical reference was in 1881, when German doctor Richard von Volkmann described a permanent contracture of the forearm related to ischemia within muscle compartments of the arm.

https://en.wikipedia.org/wiki/Volkmann%27s_contracture
Anatomy Review

- **Compartments** – grouping of muscles, nerves and blood vessels in the extremities
- Inelastic fascia encases the compartments, protects the tissues, and maintains tissue shape

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Lower Extremity Compartments - Calf

- **Anterior**
  - **MOST** likely to be affected
  - Tibialis anterior, extensor muscles of toes, anterior tibial artery, and deep peroneal nerve

- **Lateral**
  - Peroneus longus and peroneus brevis, superficial peroneal artery

- **Deep Posterior**
  - Tibialis posterior, flexor digitorum longus, and flexor hallus longus

  **Superficial Posterior**
  - Gastrocnemius and soleus muscle.
  - Sural nerve
  - Lithotomy positions

Figure 1. Cross-section Medial Calf. Adapted from “Grey’s Anatomy,” 2009. Retrieved from: https://radiopaedia.org/images/24012
Calf Cross - Section

Figure 3: Cross-sectional anatomy of the calf

Lower Extremity Compartments – Thigh

- **Anterior**
  - Vastus lateralis, vastus intermedius, sartorius, and recutus femoris
  - Femoral nerve/artery

- **Medial**
  - Pectineus, external obturator, gracilis muscles
  - Adductors
  - Obturator nerve

- **Posterior**
  - Semimembranosus, semitendinosis, and biceps femoris
  - Sciatic nerve

Figure 2. Cross-section Medial Calf. Adapted from “Grey’s Anatomy,” 2009. Retrieved from: https://radiopaedia.org/images/24012
Physical Assessment

- Lower Extremity - Calf
  - Deep Peroneal Nerve (most commonly affected) - anterior compartment.
  - Sensory territory is confined to webspace between 1st and 2nd toes and activates dorsiflexion.

- Superficial Peroneal Nerve runs along lateral compartment and supplies dorsum of the foot (except 1st webspace).

- Posterior Tibial Nerve is within deep posterior compartment and provides sensation to plantar surface of the foot – motor function is flexion of the toes.

Physical Assessment

- **Lower Extremity - Thigh**
- **Femoral Nerve**
  - Anterior Compartment
  - Most commonly affected
- **Obturator Nerve**
  - Medial Compartment of thigh
- **Sciatic Nerve**
  - Posterior Compartment of thigh

Physical Assessment

• **Upper Extremity**
  • **Radial Nerve**
    • Back of the arm and wraps around to skin of forearms and hands
  • **Median Nerve**
    • Main nerves of arm that runs full length
    • Axilla injury
  • **Ulnar Nerve**
    • Extends from cervical collar
    • 4\textsuperscript{th} and 5\textsuperscript{th} digits

Pathophysiology

Muscle Perfusion Pressure =

Diastolic Blood Pressure - Intra-Muscular Pressure

Two General Principles:

- DECREASED space within compartment
- INCREASE within compartment content

Multiple pathways leading to final common pathway: cellular anoxia ➔ death of the muscle within compartment.
Causes of ACS

Any event (external or internal) that increases the pressure within a compartment by decreasing the capacity or increasing the volume

- **Bone fracture** (trauma or intentional) ~70%
- Crush Injury
- Hemorrhage (anticoagulation, intramuscular injury)
- Less common causes… r/t fluid retention – rhabdomyolysis, muscle hypertrophy, DVT
- Tight casts/splints/circumferential dressings/tourniquet
- Burns
- Injection injury/Extravasation
- Intra-osseous infusions
- Infection
- **Surgical positioning**
Clinical Presentation

<table>
<thead>
<tr>
<th>6 P’s</th>
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<tbody>
<tr>
<td>Pain</td>
<td>Pallor</td>
</tr>
<tr>
<td>Pressure</td>
<td>Pulselessness</td>
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<tr>
<td>Paresthesia</td>
<td>Paralysis</td>
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</tbody>
</table>
PAIN

• Pain that is out of proportion to the injury

• Pain with passive stretch of muscle

• Persistent deep ache or burning

FIRST presenting symptom
PRESSURE

- Often not utilized – proper equipment required and user errors are common
- >30-40 mmHg considered diagnostic
PARESTHESIA

- A condition in which you feel sensation of numbness or prickling
- Pins & Needles
- Early → contained to one compartment
- Late → globally within limb
PALLOR

- Rarely present
- Often times, redness progresses to pallor
- Sign of vascular injury and quickly leads to ischemia
- LATE stage – emergent intervention require
PULSELESSNESS

- The existence of distal pulses DO NOT exclude compartment syndrome
- Check above and below area of concern
- Late stage – indicates progression

https://upload.wikimedia.org/wikipedia/commons/thumb/d/d1/Pulse_sites-en.svg/220px-Pulse_sites-en.svg.png
PARALYSIS

- Complete loss of muscle function for one or more muscle groups
- Very late finding → indicating nerve damage

![Diagram](http://drawingbooks.org/lutz1/source/images/000088.png)
Who is at risk?

Bone Fracture (2/3 of patients)
- Tibia/radius most commonly seen
- Trauma

Increased Muscle Mass

Cast/Splint on broken bone

OR - same position for > 8 hrs

Lithotomy

Men in their 30’s
Diagnosis

Difficult to DEFINATIVELY diagnose early on

Early Stage:
• Extreme, unrelenting pain
• Elevated intracompartmental pressure

Late stage:
• Hyperkalemia from muscle breakdown
• Acute renal failure or myoglobinuria
Diagnosis

Stryker Manometer is most commonly used

- Normal at rest
  0 - 10 mmHg

- Pressures > 30-40 mmHg require surgical decompression, combined with supporting clinical picture

A solid-state transducer intracompartmental catheter (STIC) may be used, which is more accurate and reliable.

Can monitor ICP for up to 16 hours.

https://www.slideshare.net/drrohitvikas/compartment-syndrome-14077010
## Support Your Case

<table>
<thead>
<tr>
<th>What are the precipitating factors?</th>
<th>Can use measure the pressure within the compartment?</th>
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<tbody>
<tr>
<td>Is this a high risk patient?</td>
<td>Is it &gt;30 – 40 mmHg?</td>
</tr>
<tr>
<td>Imaging</td>
<td>Additional helpful objective information</td>
</tr>
<tr>
<td>• MRI/CT scan can show swelling of the gluteal muscles</td>
<td>• Elevated creatinine phosphokinase (CPK) indicates muscle damage or ischemia</td>
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Treatment

- Surgical decompression with a fasciotomy is the definitive treatment.
- 8 hour ischemia time can cause irreversible damage to muscles.
Case Study – Review the Facts

- Age – young males at high risk
- Obese – muscular patients are often at higher risk, but could weight and gravity play a factor?
- Time – OR for 10 hours, supine and intubated for at least another 12 hours – unable to communicate pain.
- Pain – Very tender. Exquisitely tender to touch. Is there pain when flexing the hip?
Case Study #2

- 26 y/o athletic male with no prior medical history
- Playing soccer on day prior to admission was kicked in R thigh sustaining a hairline femur fracture
- Admitted for observation
  - Ambulated w/pain into urgent care
  - Denied numbness/tingling
  - Labs on admission:
    - CPK 971 (22-198) K 5
    - WBC 12.8 H&H 12.5/35.5 PLTs 213
- Compartment pressure 45mmHg.
Fasciotomy

Incision prior to fasciotomy

Fasciotomy in progress – muscle is still beefy red and viable
Prognosis

- Overall complication rate is about 50-60% if treatment is delayed >12
- About 50% lower limbs require amputation when treatment is delayed, 92% will develop neuropathy
- Mortality is related to renal failure or sepsis
Things to Remember

• Don’t dismiss pain – look into the reason for the pain
• Don’t over medicate
• Perform a COMPLETE exam
• Don’t elevate – need to maintain perfusion
• TRUST YOUR GUT


